KABARAK UNIVERSITY

EXAMINATIONS

2008/2009 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE

COURSE CODE: **PHYS 110**

COURSE TITLE: **ELECTRICITY AND MAGNETISM**

STREAM: **Y1S1**

DAY: **TUESDAY**

TIME: **9.00 – 11.00 A.M.**

DATE: **11/08/2009**

INSTRUCTIONS

1. *Answer **Question One** and any other **Two***
2. *Electric charge $e = 1.6 \times 10^{-19} C$*
3. *$\varepsilon_o = 8.85 \times 10^{-12} F/m$, $\mu_o = 4\pi \times 10^{-7} Tm/A$, $h = 6.63 \times 10^{-34} J.s$, $1eV = 1.6 \times 10^{-19} J$*
4. *$Me = 9.11 \times 10^{-31} kg$,*

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QUESTION 1 (30 MARKS)

a.) Give any two statements of Gauss's law. (2 marks)

b.) Using a diagram of a capacitor with a dielectric, show that the presence of a dielectric increases amount of charge stored by a capacitor. (4 marks)

c.) A small object carrying a charge of -5 X 10^{-9}C experiences a downward force of 20 X 10^{-9}N when placed at a certain point in an electric field;

i.) What is the electric field at the point? (2 marks)

ii.) What would be the magnitude and direction of the force acting on an electron placed at the point if the field is the same? (2 marks)

d.) A metal sphere of radius r_a is supported on an insulating stand at the center of a hollow metal sphere of inner radius r_b. There is a charge +q on the inner sphere and a charge – q on the outer part. Show that the potential difference between the plates is

$$V_{ab} = \frac{q}{4\pi\varepsilon_o}\left(\frac{1}{r_a} - \frac{1}{r_b}\right)$$ (4 marks)

e.) A parallel plate capacitor has an area of $1m^2$ with its plates at 5mm apart. A potential difference of 450V is applied across the capacitor. Find;

i.) Capacitance

ii.) Charge on each plate. (5 marks)

f.) Figure 1 below shows resistors connected both in parallel and series.

i.) Calculate the equivalent resistance of the circuit. (3 marks)

ii.) What is the potential difference between **x** and **a** if the current in the 8Ω resistor is 0.5A? (3 marks)

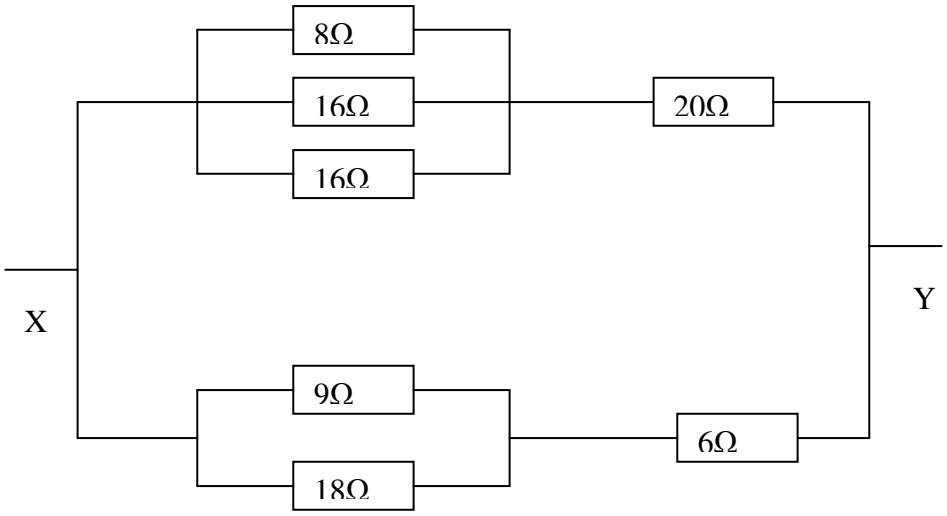

Fig 1

g.) Give the difference between resistivity and resistance of a material. (2 marks)

h.) A 1.0μF capacitor with an initial stored energy of 0.50J is discharged through a 1.0MΩ resistor;

i.) What is the initial charge on the capacitor? (1 mark)

ii.) What is the current through the resistor when the discharge starts? (3 marks)

QUESTION 2 (20 MARKS)

a.) Give two properties of magnetism. (2 marks)

b.) An electron moves into a region of uniform magnetic field **B** of magnitude 4.55 X 10^{-4}T. The angle between the directions of **B** and the electron's velocity **V** is 65.5^0. If this electron creates a force of 1.32 X 10^{-20}N; determine

i.) The velocity of motion of this charge. (3 marks)

ii.) The radius it can execute in the field if the path is circular. (3 marks)

c.) i.) State Ampere's law. (1 mark)

ii.) Fig 2 below shows cross-section of a long conducting cylinder with inner radius a = 1 cm and outer radius b = 3 cm. The cylinder carries a current out of the page and the current density in the cross-section is given as $J = pr^2$ where p = 3.0 X 10^6 A/m^4 and r is in meters. Show that the current enclosed;

$$i_{encl.} = \frac{\pi p}{2}\left(r^4 - a^4\right)$$ (4 marks)

Hence find the magnetic field B at a point that is 3cm from the central axis of the cylinder? (5 marks)

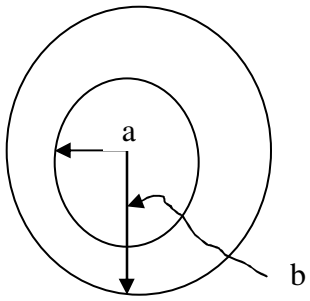

Fig 2

d.) State Kirchoff's voltage and current laws. (2 marks)

QUESTION 3 (20 MARKS)

a.) State Faraday's law. (1 mark)

b.) Show that the amount of charge q at any time t for a discharging capacitor is given as

$$q = Q_o e^{-t/RC}$$

Where symbols have their usual meaning.
Hence sketch a graph of charge q versus time t for a discharging capacitor. (5 marks)

c.) In fig 3 below what is the net potential in terms of charge q and distance d at point P due to the four point charges if V = 0 at infinity?

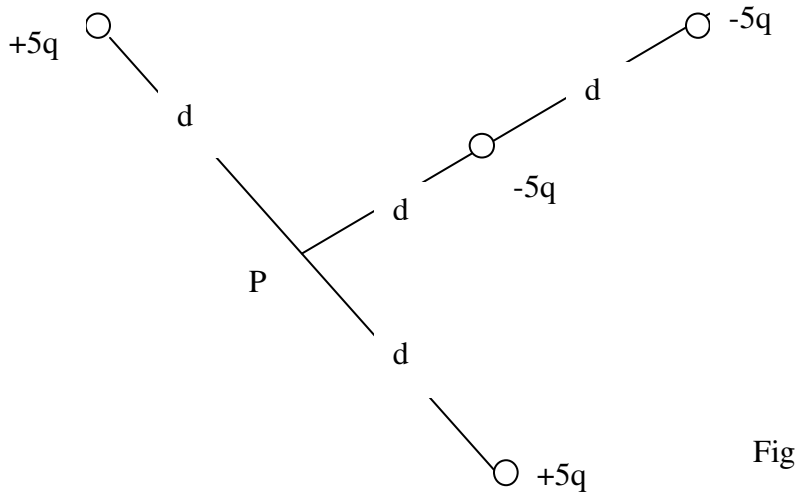

Fig 3

d.) i.) State Ohm's law. (1 mark)
ii.) State a characteristic plot of an Ohmic conductor. (2 marks)

e.) Fig 4 below shows a circuit whose elements have the following values;
$E_1 = 3.0V$, $E_2 = 6.0V$, $R_1 = 2.0\Omega$ and $R_2 = 4.0\Omega$.
The three batteries are ideal. Find the magnitude and direction of the current in each of the three batteries.

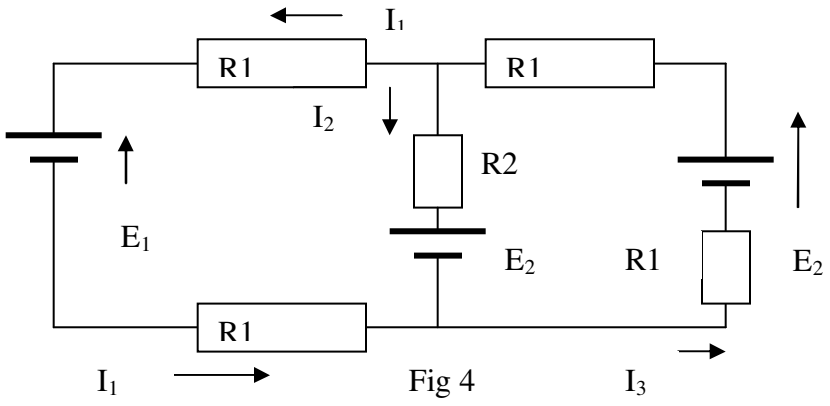

Fig 4

QUESTION 4 (20 MARKS)

a.) The current in a wire varies with time according to the relation

$i = 4 + 2t^2$

Where i is in amperes and t in seconds.

i.) How many coulombs pass across section of the wire in the time interval between t = 5s and t = 10s? (4 marks)

ii.) What constant current would transport the same charge in the same time interval? (3 marks)

b.) Show quantitatively that electric flux through a surface enclosing a charge is independent of the size of surface (or distance from the charge). (4 marks)

c.) Give two sources of energy losses in a transformer. (2 marks)

d.) Three charges $q_1 = q_2 = 3\mu C$ and $q_3 = -2\mu C$ are placed as shown in figure 5 below. The distance between the charges q_1 and q_2 and q_1 and q_3 is 0.015m. Calculate force on q_1.

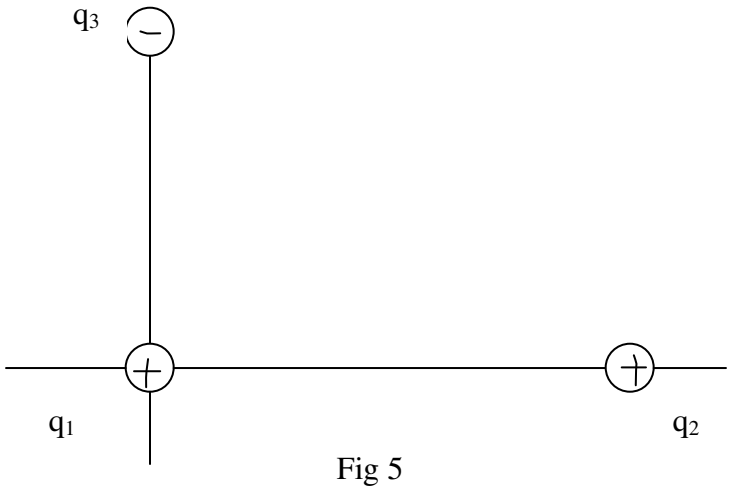

Fig 5

e.) Show that potential energy U created by moving a negative charge a distance r from a positive charge is given as;

$$U = \frac{1}{4\pi\varepsilon_o}\frac{q_1 q_2}{r}$$ (3 marks)